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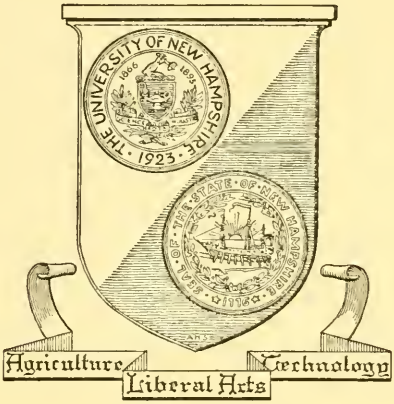

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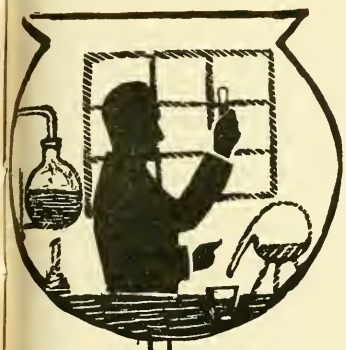

Bulletin 304 March, 1938

Agricultural Research In New Hampshire

Annual Report of the Director of New Hampshire Agricultural Experiment Station for the Year 1937

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Agricultural Research in New Hampshire

ANNUAL REPORT
of the
New Hampshire Agricultural Experiment Station, 1937

J. C. KENDALL, *Director*

The existence of a problem indicates the need of education, and frequently the first call is for research. Problems come fast these days in agriculture, and research has to keep pace with them. There is a tendency observable to demand quick action and speedy publication of results; and in some types of projects, particularly those related to economics, it may indeed be a case of swift action or none at all.

Clearly, research should respond to this demand of the times, provided accuracy is not sacrificed in the process. We have frequently placed in the hands of extension workers the result of research as soon as it was "out of the oven." On occasion, members of the staff have left long-time assignments to tackle immediately pressing problems. We have not hesitated, when advisable, to speed publication by means of mimeographing or to present results of work informally at conferences in advance of publication.

Such an instance this last year was a study of the effect of the Agricultural Conservation Program in the state. To what extent is the program bringing about changes that will make for more permanent and profitable farming? What factors have prevented complete participation of farmers? What practices and what type of program would be most effective in bringing about the best use of land resources? These questions were of immediate public importance, and a study was projected quickly last summer in representative towns of the state in time to throw some light on the proposed program of the following year.

On the other hand, it is true that most agricultural research projects can only be satisfactorily consummated over longer periods. The varying influence of different seasons or conditions and the necessity for a complete picture through the accumulation of data, the replication of plots and the calculation of probable errors call for exacting and time-consuming study. The high standards of accurate analysis and correct interpretation of results must not be lowered.

We are happy to announce the completion of a project agreement with the Soil Conservation Service of the United States Department of Agriculture for the study of soil erosion in the state. A reconnaissance survey of the New England states was carried out in 1934 which showed varying amounts of sheet erosion and some gullying in restricted locations.

"It is recognized," says the agreement, "that the problem in New England is quite possibly different from that of most other portions of continental United States, for the reason that a large proportion of the area has been and still remains in forest cover and pasture land.

"The floods of the spring of 1936 brought forth considerable comment. Data were presented showing the depths of silt deposition in the valleys of several rivers. For example, in the Winooski River Valley it was indicated that in a survey of 26 farms totalling 1,098 acres, 47.3 per cent. of the area was covered to a depth of 16-20 inches by silt and sand. Quite probably similar conditions resulted from the flood of 1927 and other previous floods.

"Data were presented showing that in some cases at least, the content of phosphorus in the debris was higher than that of a normal profile of the soil in the upstream portion from which the deposition originated. The thought was expressed that the soil quite possibly came from cultivated lands.

"Preliminary observations would indicate that erosion has occurred on pasture lands where the fertility of the soil was allowed to decline so that the grass cover became thin or over-grazing was systematically practiced. The loss of soil and breaking of the turf may have only taken place during the early spring before growth had started, but over a long period of years appreciable sheet erosion occurred.

"On plowed land, particularly where crops such as corn and potatoes were raised with the rows running up and down hill, there has been a large loss of soil during the early summer rains before a good vegetative growth had developed. At other times in the summer and fall, however, soil washing has been noted in periods of exceptional precipitation. Evidence of the effect of the gradual loss of surface soil has been given in the comments that farmers have made to the effect that the rocks tended to come to the surface so that fields eventually became too rocky to plow.

"The major part of the erosion so far observed has been caused by water, but some wind erosion has occurred in limited areas of sandy land along the Lamoille River in Vermont, in portions of Cape Cod on the sea coast and in parts of the Connecticut River Valley.

"The extent of the injury which has occurred to crop lands and pastures is not accurately known, nor are methods for controlling soil loss clearly recognized."

It is a source of great gratification that the Carnegie Institution of Washington awarded a special grant of $2,000 for the coming year for the continuation of the cooperative studies in animal nutrition. These fundamental investigations were first made possible through the interest of Dr. Francis G. Benedict of that institution and have been conducted since 1918 with his active cooperation and counsel. Upon his reaching the age of retirement, it has been necessary to face some new arrangement, and the action of the Carnegie board in approving the continuation of funds under Professor Ritzman's supervision is deeply appreciated.

A serious set-back was incurred in midsummer when the wooden building, formerly the dairy barn, which had housed the Agricultural Engineering department, was lost by fire. A considerable amount of

equipment was destroyed in the conflagration. The Board of Trustees met the resulting housing crisis by voting to start construction of a new brick building at once to be known as Pettee Hall in honor of the late Dean C. H. Pettee and to quarter the Agricultural Engineering as well as the Military and Home Economics staffs.

Other improvements during the year were additions to the poultry plant for further nutrition and disease-control work and the construction of a potato and soils storage building in the rear of the greenhouses.

Miss Mary L. Geraghty was appointed statistical assistant and Mr. Lucian Geoffrion draftsman in agricultural economics during the year. Mr. Victor H. Smith was temporarily employed in cooperation with the Bureau of Agricultural Economics, U. S. D. A., in the study of the Agricultural Conservation Program. Mr. Arno Hangas, research assistant in agricultural economics, resigned October 1. During the absence on leave of W. A. Westgate, Miss Barbara Miner has been employed as research assistant in entomology.

PUBLICATIONS ISSUED

Details of results in certain projects were published during the year as follows:

Station Bulletin 292	Inspection of Commercial Feeding Stuffs, 1936
Station Bulletin 293	Results of Seed Tests for 1936
Station Bulletin 294	Inspection of Commercial Fertilizers for 1936
Station Bulletin 295	The Milksheds of New Hampshire
Station Bulletin 296	Station Report, 1936
Station Bulletin 297	Inspection of Commercial Feeding Stuffs, 1937
Station Bulletin 298	Land Utilization in New Hampshire
Station Circular 51	Epidemic Tremors (Trembling Chick Disease)
Station Circular 52	Growth and Feed Standards for New Hampshire
Station Circular 53	Type-of-Farming Areas in New Hampshire
Technical Bulletin 67	Effect of Delay in Storage and Storage Temperature on Keeping Qualities of Apples
Technical Bulletin 68	The Performance of Certain Contact Agents on Various Plant Surfaces
Scientific Contribution 50	Factors Affecting Cold Resistance in Plants
Scientific Contribution 51	Value of the Dye-Adsorption Test for Predetermining the Degree of Hardiness
Scientific Contribution 52	Frost Rings in Hardy Varieties of Apple
Scientific Contribution 53	Double Growth Rings in Red Astrachan
Scientific Contribution 54	Unusual and Severe Winter Injury to the Trunks of McIntosh Apple Trees in N. H.
Scientific Contribution 55	A Comparison of Manure and Peat for Greenhouse Tomato Culture

Scientific Contribution 56	Biennial Bearing of McIntosh
Scientific Contribution 57	Can Bees Retain Pollen of Early Apple Varieties for Effective Pollination of Later Blooming Sorts?
Scientific Contribution 58	Self- and Cross-Pollination in the McIntosh Apple and Some of Its Hybrids
Scientific Contribution 59	The Effect of Reducing the Number of Functioning Stigmas on Fruit-Setting and Characteristics of the McIntosh Apple

Cutting Brush Took 55 Hours Per Acre

A study of brush removal on pasture plots by M. F. Abell indicates that burning with a fire gun takes 30.4 hours per acre, compared with 55.3 hours for cutting and 74.2 hours for pulling. Oil consumption in the burning process amounted to 17.8 gallons per acre, and re-burning on certain plots added 9.8 hours and 5.4 gallons of oil. Fertilizer applications required 4.3 hours per acre.

Five 1.5 acre areas and seven .6 acre areas were worked during the year on 12 farms scattered through the state under varying soil and brush conditions. The season was such that the large brush could not be advantageously pulled by machine. Only the smaller brush was pulled, and the rest cut. (*Purnell Fund*)

Milk Trucking Largely by Independents

About 90 per cent. of the milk hauled by commercial truckers from farm to dealer in New Hampshire is handled by independent truck drivers operating their own trucks and making their own contracts with producers and distributors, finds Alan MacLeod, who has mapped all commercial truck routes in the state.

Rates charged by independent truckers are substantially below those charged on trucks owned and operated by milk distributors. Preliminary results show an average rate of 22.7 cents per hundredweight charged by independents and 29.1 cents by distributor truckers.

The average rate paid by New Hampshire farmers for carrying their milk from the farm to the country station or city plant is about 23 cents per hundredweight or one-half cent per quart.

Rates appear to bear little or no relation to length of route, size of load, type of road, or any other factors which under fully competitive conditions might be expected to have an influence upon them. (*Bankhead-Jones Fund*)

Great Variation Found in Local Tax Rates

Local tax rates in New Hampshire varied from $.56 to $5.07 per $100 of assessed valuation for the fiscal year ending January 31, 1937. Some preliminary work is being done by H. C. Grinnell, in an attempt to account for this wide range in tax rates. Twenty-five towns have been surveyed. A copy of the town report was obtained in each case, and this scrutinized for obvious errors and omissions. A questionnaire was completed with the aid of the various town officials concerned, the extent

of the information depending on the completeness and accuracy of the respective reports. This questionnaire includes such headings as: Highway Mileage, Highway Equipment, Wage and Truck Rates on Highways, Schools, Indebtedness and Tax Delinquency. Towns in other areas will be visited to permit a more general survey of conditions. (*Purnell Fund*)

Market Good for Some Kinds of Small Fruits

Reports from 150 hotels, tea rooms, camps and tourist homes in the state indicate that some definite market opportunities exist in such lines as early peaches, cherries, raspberries, and late and everbearing strawberries in sections where large numbers of summer people come. Very little real effort has been made to supply local markets with a continuous supply of fresh fruits by planting different kinds and varieties, finds L. A. Dougherty.

The most frequent complaint by those serving summer guests is that they cannot depend on regular service from farmers and do not know when they will come or what they will have. High prices are also frequently mentioned as a reason for using canned fruits and vegetables instead of fresh ones.

A list of persons who can and preserve vegetables and fruits has also been obtained and these are now being contacted to determine kinds of products being put up, prices, and where sales are made. The principal difficulty seems to be the high prices of raw products for canning and preserving which make it almost impossible to compete on price with products from other sections. Nevertheless, some opportunities do exist. One man in Alton was grading all his tomatoes so well that hotel trade was well pleased with them and the seconds were placed in juice and sold mostly to summer people. Generally speaking, prices are so high that little in the way of first class fruits can be used in canning and preserving.

Surpluses, if they should exist, can be disposed of to the south in Massachusetts where seasons are earlier, or they can within limits be utilized in canning and preserving for sale to summer visitors. (*Purnell Fund*)

Most Active Farms in Conservation Program

About 84 per cent. of the active farms in the state were included in the work-sheets of the Agricultural Conservation Program, if the percentage found in 12 representative towns held throughout New Hampshire. Brief records were taken on 1,900 farms. Of these only 664 or 35 per cent. signed work-sheets; but a classification of them showed the following division:

	Total	In program	% in program
Commercial farms			
Active	339	286	84.36
Less active	350	185	52.85
Non-commercial farms			
Subsistence	336	114	33.92
Residence	805	67	8.32
Miscellaneous	70	12	17.14
Total	1,900	664	34.94

In these 12 towns 59 per cent. of all farm acreage, 59 per cent. of all tillage land, and 78 per cent. of the cows were represented in the farms which were signed up in 1937.

Practically all of the progressive conservation farming practices were carried out on farms in the program. This is indicated in the total practices carried out on the 1,900 farms as compared with those on the 667 which signed up for the program.

The following practices were reported on the 1,900 farms:

Practice	Total	In program	% in program
Acres of new seeding	2,528	2,229	88.13
Tons of lime on new seeding	1,408.45	1,356.15	96.28
Tons of fertilizer on new seeding	116.07	114.67	98.79
Tons of fertilizer on hay land	98.44	96.74	98.27
Acres of pasture improvement	785	773.5	98.85
Tons of lime used on pastures	78.1	78.1	100.00
Tons of fertilizer used on pastures	36.27	36.22	99.86
Acres of pasture re-seeding	98.5	92.5	93.90
Acres of green manure crops	319.5	317.5	99.52
M. Forest trees planted	8.5	8.0	94.11
Acres of woodlot thinning	94.0	87.0	92.55
Tons of orchard mulch	74.0	74.0	100.00

There has been a definite increase in progressive practices as indicated by a comparison of 1937 and 1935. For instance, in 1937 the acres of new seedings were 2,528 as compared with 1,841 in 1935. This is an increase of 681 acres, or 37 per cent. However, the acres of new seeding are still very low and represent only two per cent. of the total tillage land on the farms in the program.

Total Acres New Seedings—1935 and 1937

	1935	1937	Change
Commercial			
Active	1,312	1,665	353
Less active	377	559	182
Non-commercial			
Subsistence	123	229	106
Residence	21	47	26
Miscellaneous	8	28	20
All farms	1,841	2,528	687

The work was in charge of Harry C. Woodworth, Emil Rauchenstein, and Victor H. Smith. (*Purnell Fund in cooperation with Bureau of Agricultural Economics, U. S. D. A.*)

Milk Solids-Not-Fat Upset Standards

Milk standards based on total solids content are in danger of being unfair because of normal fluctuations in the solids-not-fat. Studying composite samples run on the University dairy herd for the last three years, H. C. Moore finds that there is almost an inverse relationship between the production per cow per day and the average per cent. fat in the milk—a normal relationship to be expected—but that there is no correlation between the per cent. solids-not-fat and the production per cow per day.

Pastures at the University have been especially good each spring and fall for the last two years, and this condition is reflected in the fact that

the average solids-not-fat content in the dairy herd milk reached its highest point of 8.91 per cent. for the months of June and October.

On the other hand, records of other herds that are not fed according to production or that receive little or no grain for a part of the year do not show this relationship.

Fifteen-day composite samples from various herds throughout the state over the same period show that during the months of July, August, September, October, and November, the solids-not-fat content of the milk is below normal for the fat content. The rest of the year the relation of the fat to solids-not-fat is about normal. About a third of the herd which would be below the Massachusetts State Legal Standard on total solids content would have been placed there by the solids-not-fat. The attempt to apply a "normal" relationship between fat and solids-not-fat shows that about two-thirds of the samples testing 3.4, 3.5, 3.6, 3.7 and 3.8 per cent. contained less than the normal amount of solids-not-fat for the fat tests, the percentages below normal being 70, 69, 65, 64, and 62 respectively. The average solids-not-fat content ran from 0.14 per cent. to 0.07 per cent. below the normal for the fat test. The average difference from the normal was —0.11 per cent—the same figure found by the Whiting Co. in a report on samples run in their laboratories.

Further observations of the possible effect of mastitis upon total solids in milk were made by H. C. Moore and L. W. Slanetz. Samples from six cows in the University herd that all freshened within a month of one another, showed three negative to mastitis and three positively infected in one or more quarters. The mastitis cows showed +.17 more per cent. fat and —.53 per cent. less solids-not-fat than the clean cows.

A paper on the methods used in taking the samples directly from the combine jar was given at the annual meeting of the American Dairy Science Association at Lincoln, Nebraska. (*Purnell Fund*)

Cod Liver Oil Helps Calves

Further indication that cod liver oil, supplementing skim milk, will promote satisfactory growth of calves was obtained by K. S. Morrow. A group of two Holsteins, one Jersey and one Ayrshire calf was fed as follows:

Calf left with dam for 12 hours. Dam's milk fed for first three days. Beginning with the fourth day, skim milk plus cod liver oil concentrate (added at rate of one teaspoonful per day) was fed. At beginning of third week cod liver oil concentrate increased to two teaspoonfuls per day.

All milk was fed at the rate of 1.2 pounds of milk daily for each ten pounds live weight of animal up to a maximum of 18 pounds daily.

Grain was started as soon as the calf would eat it, fed up to limit of appetite, not to exceed four pounds per day. It consisted of a ration of cornmeal, 400 pounds; wheat bran, 300 pounds; ground oats, 200 pounds; linseed oil meal, 100 pounds; cottonseed oil meal, 100 pounds; salt, 12 pounds; bone meal, 12 pounds and cod liver oil concentrate added at rate of five pounds per ton.

Compared with last year's rations, the present rate of milk feeding

was increased from 10 to 12 per cent. of live weight, and grain feeding was limited to four pounds daily instead of five. It was observed in the previous trial that the animals laid on considerable fat towards the end of the six-month period. Since grain must be purchased on most New Hampshire farms, a saving in the amount fed without hampering growth is of economic importance.

All grain and milk fed was weighed daily. Hay was weighed occasionally, but it was impossible to determine individual consumption since the entire group ate from a common supply.

The calves showed at first an average weight of 73.5 pounds (101 per cent. of normal), and at the end of 150 days 321.2 pounds (118 per cent. of normal). The average daily gain was 1.65 pounds at a cost of 8.7 cents per pound gain. (*Bankhead-Jones Offset Fund*)

Winter Injury of Apple Trees

The widespread winter injury to apple trees from the extremely low temperatures in December, 1933, and again in February, 1934, has provided an unusual opportunity for the further study of its nature, causes, and prevention. One factor considered of possible significance is the fall application of nitrogenous fertilizers.

Sixty-three small *Baldwin* trees, having trunk diameters ranging from 1¼ to 2 inches and situated in the 1926 block of the University of New Hampshire orchard, were divided into seven blocks of 9 trees each on the basis of similarity in size, vigor, and situation. The trees in each block received one of the following treatments:

(1) 1 lb. of cyanamid Sept. 2.
(2) 1 lb. of cyanamid Sept. 22.
(3) 1 lb. of cyanamid Oct. 14.
(4) 1 lb. of cyanamid Nov. 5.
(5) 1¼ lb. of sulphate of ammonia Sept. 2.
(6) 1¼ lb. of sulphate of ammonia Sept. 22.
(7) 1¼ lb. of sulphate of ammonia Oct. 14.
(8) 1¼ lb. of sulphate of ammonia Nov. 5.
(9) Control not fertilized.

Of the seven trees treated with sulphate of ammonia Oct. 14, two died following symptoms similar to those described by Rawlings and Potter, two more show the same type of trunk injury but are still alive; one showed some loosening of the bark, and the other two were uninjured.

Six of the seven trees fertilized with one pound of cyanamid on the same date were uninjured. The seventh showed typical injury to the trunk, the foliage turned yellow in June, and the tree died later in the season. One tree fertilized with sulphate of ammonia Nov. 5, showed a small area of typical trunk injury. All of the control trees and those fertilized with cyanamid or sulphate of ammonia on other dates showed no injury during 1937 which was not present when the experiment began in the fall of 1936.

In late November of 1936 an orchard was found in Cheshire County in which some four or five rows of trees had been fall fertilized in 1935. Rows in the center of the orchard which had had a heavy crop in 1935 developed injury similar to that observed in other fall fertilized orchards.

However, the outside rows which had had no crop during the season preceding the fertilization showed no injury whatever. It is quite possible that only trees which have borne heavily during the preceding season are susceptible to this injury. The work has been in charge of G. F. Potter, W. W. Smith and M. A. Tingley. Chemical studies have been made by T. G. Phillips of samples taken at intervals during the winter from the roots, trunk, and branches of trees which had been heavily fertilized and of their non-fertilized controls. There appears to be a distinctly higher concentration of soluble nitrogen in the roots of fall fertilized than of control trees. Samples from the trunk and branches seem to show no consistent differences due to the fertilizer treatment. (*Adams Fund*)

Studies in Blossom Bud Formation

Four or five per cent. more spurs blossomed last spring in the apple plots sprayed throughout the season with mild sulphur than on the plot sprayed with lime sulphur solution in 1934. This rather small difference is the first observed, reports G. F. Potter. Since the formation of blossoms is conditioned rather early in the season, those formed in 1934, the first year of the experiment, may not have been influenced by the treatments. Owing to a pronounced biennial bearing tendency, practically none were formed in any plot in 1935. The blossoms opening this season were formed in 1936, and may well be the first that could show a response to the spraying.

The percentage of blossoms setting fruit in 1937 was very markedly influenced by the spray treatment, being 10 to 20 per cent. higher on the mild sulphur plots. In spite of the heavy set the apples grew as large as on the lime sulphur plots, and, in consequence, the crop was much heavier. This circumstance of heavy set and heavy crop will have a tendency this season to reduce fruit bud formation for next year on these trees. The leaf area was measured in midseason. There were 13 to 14 square inches per spur on the mild sulphur plot and less than 9 on the lime sulphur. This very significant difference may be due in part to injury to the foliage which occurred this year and in part to higher reserves of food stored in the tree from the previous season.

Some trees of Northern Spy are also included in this block and receive the same treatments as the McIntosh. Unfortunately, time did not permit making a fruit spur count. Yield records indicate that, both this season and as an average for the seasons of 1936 and 1937, the trees sprayed with mild sulphur have been more productive than those sprayed with lime sulphur. The differences are striking and of strong statistical significance. (*Adams Fund*)

Relation of Thinning to Blossom Bud Formation

Further observations were made this season by G. F. Potter on the McIntosh trees in which biennial bearing had been overcome in 1936 by thinning the fruit early in 1935. (Potter, Proc. A. S. H. S. 34:139) The trees thinned in 1935 bore a good crop in 1936, while those not thinned had practically no fruit. Nevertheless, blossom bud formation on these plots differed by only a small amount—much too small to

be significant under the conditions of this experiment. Production was heavy in all plots. It remains to be seen whether or not these trees will all revert to biennial bearing in 1938. This is a very important question from a practical point of view. It is hoped that the McIntosh can be maintained in reasonably good annual production by thinning only in those years when weather conditions produce an exceptionally heavy set.

Since it was evident before the blossom period of 1936 that blossoming in the McIntosh had been controlled to a considerable extent by thinning, the experiments were extended in the spring of 1936 to a number of Baldwin trees in Amherst, N. H. At the time of the first visit, three weeks after the blossoms had been thinned by removing three-quarters of the blossom clusters, it was found that practically every flower in the blossom clusters left on the trees had set fruit. Since this number would produce a heavy crop, all but one fruit was removed from each spur. The results were exceedingly disappointing—blossom bud formation in every case being so low that it was not worthwhile in the spring of 1937 to make counts of the percentage of spurs blossoming. None of the trees had more than one per cent. bloom.

Another series of 18 heavily laden Baldwin trees was thinned between three and four weeks after the blossom period to about 75 leaves per fruit. This is a rather severe thinning. The average yield of these trees was 236 pounds, while their unthinned controls produced an average of 352 pounds. The size of the apples was increased from 2.63 to 2.86 inches diameter, and the proportion of the surface having a good shade of red was raised from 48% to 56%. In spite of this fact blossom bud formation on both thinned trees and controls was so meager that, on examination in the spring of 1937, it was considered not worthwhile to make counts of the fruit spurs to determine the proportion of bloom. It was found at harvest that there was more fruit on the thinned than on the unthinned trees.

These thinning experiments have demonstrated that removal of the fruit three weeks after bloom has a very definite effect upon blossom bud formation in the McIntosh but little or none in the Baldwin. The cultural treatment, of course, must make itself felt through some change which it brings about in the nutrition of the tree. It seems clear that in the Baldwin a longer period is required to create this change or a greater change is necessary in order to influence blossom bud formation.

In tests incidental to pollination experiments, L. P. Latimer has gathered data on the percentage of spurs blossoming in 1936 on individual branches of a single McIntosh tree, following removal of the blossoms from different proportions of the spurs in 1935.

Branches in which every spur was allowed to set fruit in 1935 produced no blossoms in 1936. When blossoms were removed from every other spur on the branch, 10.9% of the spurs produced blossoms in 1936. With blossoms remaining on only one spur out of four on the branch in 1935, 27.2% of the spurs blossomed in 1936. With only one out of eight spurs containing blossoms in 1935, 49% of the spurs blossomed in 1936. In the case of the removal of 15 out of 16 of the blossom spurs, 78% of the spurs bloomed in 1936. As a check certain un-

treated branches had blossoms on 10.8% of the fruit spurs in 1936. These branches set less heavily than those from which the non-blossoming spurs were removed. It should be stated that this tree produced a very heavy crop of fruit in 1935. The result of the check compared favorably with the branches in which blossoms were allowed to remain on every other spur. (*Adams Fund*)

Apple Crates Compared in Storage

Rate of cooling of apples in two types of eastern apple crates was compared by W. W. Smith in a continuation of our storage studies. Both crates are 11″ deep, 14″ wide and about 17″ long. The sides are cut 9½″ wide, leaving a ¾″ space at the top and the bottom for ventilation. Style 5 is reinforced with corner posts inside the box. When stacked, these crates fit tightly together, allowing little or no vertical air movement. Some instances of excessive ripening of McIntosh in the center of large piles in storage have come to our attention. However, the air spaces at the top and bottom of the sides provide horizontal channels through the pile, running crossways of the boxes.

Style 4 has vertical cleats 7/16″ thick on the outsides of the ends. Thus when stacked end to end, vertical channels between the ends of the boxes 14/16″ by 11″ extend from top to bottom of the pile. A horizontal slot in the end of each box serves as a hand-hold and at the same time allows air passing through these channels to enter the boxes. The same crosswise ventilation is provided as in the Style 5. It would appear that this design would effect a more rapid cooling of the apples when placed in storage.

The test was carried out in a room 15′ x 18′ x 8′ high refrigerated by a York blower unit, which stands at one end. In filling such a room the best procedure is to stack the apples tightly in tiers running crossways of the room, but having a space at the top and also at the rear of the room opposite the blower. The cold air is blown out of the top of the unit near the ceiling, over the stack, down behind it, and forced to filter through the pile to be taken in again at the base of the blower.

After a preliminary trial which showed that there was much variation between individual boxes as they come from the field, 100 boxes of each type were filled with McIntosh and placed in a warm receiving room for two days to allow the fruit to come to uniform temperature. Then the boxes were stacked in the storage room, five by five, and four deep. The central boxes in these stacks were at the same temperature when moved to cold storage. The temperature in the "No. 4 box" stack dropped very slightly faster down to 35° F., when the "No. 5 box" stack overtook it and continued thereafter to be a little the cooler. The differences were rather small.

The third and principal test was made using 280 boxes of each type filled with Northern Spy apples, which were stacked 8 x 5 and 7 boxes high in the fruit handling room with the thermographs and thermocouples in place. After five days it appeared that there was a persistent difference of about 3° F. in the temperatures of the middle boxes of the two stacks. Since at these temperatures considerable heat is generated by respiration, it is probable that the lower temperature in

the stack of Type No. 4 crates was due to better dissipation of this heat by air circulation through the vertical channels previously described.

At this point the fruit was removed to the blower room and stacked with the long axis of the boxes crossways of the room. In this position it was believed that the air would move from the space at the rear of the pile, through the crosswise channels previously described, and thus to the blower unit. Tests with lighted tapers indicated that this was indeed the case.

The Style 4 box maintained the slightly lower temperature at which it was placed in storage, but gave no evidence of superior air circulation under the conditions prevailing in this room.

It may be concluded that with forced draft air circulation, ventilation is adequate in the Style 5 crate. The experience in the receiving room seems to indicate that in rooms with gravity air circulation the Style 4 would have an advantage.

Three lots of McIntosh apples picked at the usual time were stored respectively at 30°, 32° and 38° F. Those stored at 30° temperature kept longest and had least spoilage in storage, but never did develop a characteristic flavor. Their flavor at all tests was characteristic of immaturity and they were decidedly lacking in the McIntosh aroma. Those stored at 32° kept over a long period of time and developed fairly good flavor, although they tasted somewhat immature. Those stored at 38° reached a fine flavor quickly but were short lived. Apparently, this temperature is too high to store McIntosh except for an early market as for instance before Christmas. These results bear out those of E. J. Rasmussen and support his conclusion that it is not feasible to store McIntosh at a temperature lower than 32° F. Five years' studies of storage of apples under varying temperatures and conditions were reported during the year in Technical Bulletin 67. (*Purnell Fund*)

Apple Pollination Studies

Reciprocal pollination of Cortland and Early McIntosh made during the year have shown that the two varieties are cross-unfruitful.

Work was also begun to test varieties other than McIntosh for their response to the pollination of only one pistil per flower. Results with Cortland indicated that it behaves like McIntosh in this respect, there being slightly fewer seeds and more empty cavities and a few more lopsided fruits than when all pistils are pollinated. With King it was found that the effect was even more pronounced.

The pollination of only one pistil in the flower may give nearly as good a set of fruit as when all five are pollinated, indicating that in other varieties besides McIntosh, pollen tubes may travel from a single pistil to various carpels of the fruit. However, with King and Cortland in 1937, as with McIntosh in previous years, there seems to be on the average one cavity in each fruit without any seed.

A study was also begun of the effect of the removal of petals or of stamens or both on set of fruit when the flowers were left to open pollination. In the case of King removal of stamens alone did not seem to affect the amount of fruit set. With Winter Banana only a third as much fruit set as when the flowers remained intact and with Golden

Delicious and Spy only a fraction as much. The removal of petals had a greater effect in reducing fruit set, no fruit setting at all on Golden Delicious and Spy receiving this treatment. (*Purnell Fund*)

Orchard Fertilizer Tests

On certain orchards a "scorch" of the leaves such as might be attributed to potassium deficiency has been investigated by G. F. Potter, who has compared applications of nitrogen only with a similar quantity of nitrogen supplemented with potassium. Soil samples taken in midseason have shown that the replaceable potassium has been significantly increased down to a level of 8 inches beneath the surface of the soil. Examination of the leaves has also indicated a higher potassium content in the leaves of the potash plot. However, the increased supply of potassium in the foliage has failed to reduce this trouble significantly. It seems clear that it is not a potash scorch.

Growth and production of McIntosh trees fertilized with a complete fruit fertilizer of 5-8-7 composition has been compared with that of control trees fertilized only with an equivalent amount of nitrogen carried in cyanamid, nitrate of soda, or sulphate of ammonia. In the cultivated plot of 18 year old trees at the University of New Hampshire no significant differences were found for 1937 in yield, size of fruit, per cent. of red color, per cent. of spurs producing flowers, and per cent. of flowers setting fruit. The same is true of averages for the period 1930-37. However, the percentage of drops at harvest time was significantly higher in the complete than in the nitrogen plot both for 1937 and as an average for 1936-37. The percentage of drops has been tabulated only for the last two seasons.

Similar studies over a six-year period in a sod mulch orchard at Pittsfield, N. H., show a slightly lower set and slightly better color for the complete fertilizer plot. (*Hatch Fund*)

Strawberry Fertilizer Tests

Investigating the reasons for the decreased yield of strawberries following application of sodium nitrate and other salts, L. P. Latimer conducted experiments in 220 plots. Sodium nitrate, sodium phosphate, and sodium sulphate all reduced the yield of fruit, while the same salts of ammonium and calcium did not. The total leaf area per plant and the area of each individual leaflet was cut in half. The length of petioles or height of plant was reduced about 50% by the treatment although there was no significant reduction in the total number of leaves per plant. The damage seems to have been a dwarfing of plant parts. Although no measurements were made of the size of fruit, it was evident that the fruit was considerably smaller in the sodium plot. It is believed that reduction in yield was due to smaller fruit rather than the production of fewer fruits. Figures on yield, height of plant, total leaf area, number of leaves per plant, and area per leaflet showed a very high correlation between the various factors except as to number of leaves per plant. Nevertheless there was some correlation between total leaf area per plant and number of leaves per plant. (*Hatch Fund*)

Strawberry Varieties

Yield records were obtained by L. P. Latimer from the following strawberry varieties in 1937: *Howard 17, Aberdeen, Lupton, Orem, Pearl, Catskill, Fairfax, Cato, Dorset* and *Commonwealth.* The yield of *Howard 17* was unusually good this year, in fact, it was one of the highest yielding sorts. *Aberdeen* also yielded a large crop of fruit. *Catskill* was the most promising of the new varieties, yielding a large quantity of good sized, bright red fruit of good quality. *Fairfax* did not yield quite so high as *Howard 17* this year, and *Dorset* was below *Fairfax.* The berries of *Dorset* tended to run small towards the end of the season while the size of *Fairfax* berries was well maintained throughout the season. *Commonwealth* produced only a medium amount of fruit which tended to be small towards the end of the season. The so-called late varieties, *Orem, Pearl,* and *Lupton,* yielded only about half as much fruit as the earlier varieties. *Lupton* yielded more fruit than either *Orem* or *Pearl.* (*Hatch Fund*)

Apple Varieties

Among the apple varieties under test by G. F. Potter the Richared appears very promising. The fruit is of a brighter color than other red sports of Delicious. To obtain good quality fruit and regular bearing with this or other strains of Delicious, early thinning of the fruit is necessary.

Contrary to previous impressions, fruit of Milton attracted much favorable comment this season. Its bright red color, tender skin, and good flavor made it popular with purchasers. Of course it cannot be planted extensively because buyers prefer McIntosh when it comes on the market 10 days to two weeks after Milton.

The favorable storage experience with Cortland when it is picked at the proper stage of maturity commends this variety. It continues to demonstrate early bearing and high yield. Its place seems to be as a substitute for Baldwin, the market price ranging with that variety rather than McIntosh. (*Hatch Fund*)

Vegetable Varieties

One of the promising vegetable varieties tested by J. R. Hepler was a new pea bean, the Lapin, said to have been originated by Michurin and imported from Poland by a Hillsboro County farmer. This bean stands erect from the ground, has high baking quality and has yielded well. The Keystone Winner muskmelon yielded well and was of high quality but seems hardly early enough for New Hampshire in ordinary seasons. Of sixty-nine varieties and strains of sweet corn, Maine Top Cross, Purdue, Golden Cross Bantam, and Charlevoix 6 were particularly promising. In the tomato trials 38 strains and varieties were grown. The hot season made a higher percentage ripen than usual. Probably the culture of the larger kinds like Marglobe and Rutgers is to be encouraged for main crop purposes. Varieties like Dwarf Champion, Walter Richard, Livingston's Globe are very low yielders; others like Bison and the Earliana type are too wrinkled and uneven to sell. (*Hatch Fund*)

Blueberry Variety Improvement

Throughout the state there seems to be a growing interest in the cultivation of the highbush blueberry. Although some of the commercial varieties which originated in New Jersey are being planted and have been grown quite successfully in Massachusetts and Michigan, there is some question as to their hardiness in this climate. To test this and other commercial characteristics, several varieties are now being grown under sod culture at the Horticultural Farm by L. P. Latimer, W. W. Smith and M. A. Tingley. Sod is used because blueberry culture under cultivation in this state would be difficult and expensive. Last year many of these plants bore a very good crop. It was noticeable that although some of these plants had large blueberries comparing favorably with commercial blueberries from cultivated fields, those that were heavily loaded bore a great many blueberries no larger than those from many of our best wild highbush plants. The small size of berries on these plants was due in part to the lack of pruning. This may indicate that we have wild plants which if cultivated would produce berries as good as any of the present named varieties.

We believe that because of the great variability in wild blueberries selection from wild seedlings is more promising than hybridization. Efforts are being made to locate the very best plants in the state; then they are to be cultivated and compared with the varieties we already have. This is essentially the process that was carried out in New Jersey in originating our present commercial varieties of highbush blueberries. It is hoped that our own selections will give us hardier varieties of equal merit in other respects.

Last fall a large quantity of hardwood cuttings of Rubel were propagated by the method described by the Michigan Experiment Station. Owing to lack of space in the propagating frames some of them were held over winter in storage and these formed heavy callus tissue on the cut ends. If callus formation is the first step towards rooting, this practice may always be advisable. It is to be tested further.

A root initiating material, indolebutyric acid, was tried on some of these highbush cuttings but without any success. Most of the research with this material has been on soft wood cuttings and, as Zimmerman and Hitchcock point out, is proportional to the amount of material taken up by the conductive tissue of the cutting. Since there is no transpiration stream in the leafless hardwood cuttings, they have no way of picking up this material except by absorption. (*Hatch Fund*)

Peach Fertilizer Study

The peach orchard has been divided into five plots, in two of which each tree receives two pounds of nitrate of soda and in three, four pounds. These trees planted in 1918 are now rather old, and in addition they have been weakened in recent years by severe winter weather. It was often assumed that such trees require a high plane of nitrogen fertilizer. However, both for the yields of 1937 and for the past two years, the extra nitrogen has produced no increase in the yield of the fruit. (*Hatch Fund*)

Transplanting Ornamental Trees

A study of the optimum time for transplanting ornamental shade trees was begun by H. S. Clapp in the autumn of 1936. Five to seven foot selected sugar maple trees (*Acer saccharum Marsh*), similar trees from woodland areas and 5′ to 7′ nursery trees of the white ash (*Fraxinus americana L.*) were used. They were planted in a sod area in order to approximate as closely as possible the conditions in lawns and meadows where such trees are usually planted. It was divided into six plots, each containing three rows of 5 plants each. One tree of each of the species as received from the nursery and one from the woodland was planted in each plot, on each of five planting dates.

The data reported are not sufficiently conclusive to warrant specific recommendations for nursery stock. However, they do indicate that late fall and late spring planting is impractical for native woodland stock in this region. (*Hatch Fund*)

Greenhouse Soil Fertility Studies

The study of the natural fertility of various soil types found in the state was continued in the greenhouse by P. N. Scripture and P. T. Blood during the winter of 1937. The soils which were used were representative of the following types: Agawam fine sandy loam, Groveton fine sandy loam, Worthington loam, Becket loam, Merrimack loamy fine sand and Colton loamy fine sand.

The samples were taken from "virgin" areas, i. e., areas that have never been cultivated or received fertilizer in any form. Large areas of these soils are under cultivation in different parts of the state and with the possible exception of the Colton and Merrimack are well adapted to all crops. In years with a plentiful supply of rainfall the Colton and Merrimack soils will also produce good yields with adequate fertilization.

The yield data showed that all the soils responded somewhat to nitrogen, provided there was a plentiful supply of phosphorus and potassium present. All soils showed a large growth response to phosphorus applications. During the latter part of the growth period, applications of potassium produced an increase in growth on all the soils. The Worthington and Becket soils showed a marked increase in growth from applications of magnesium and boron.

The response of the other soils to these elements was not noticeable. The Becket soil showed a definite increase in growth where lime was applied, but the Groveton soil failed to produce a definite increase when limed.

It will be necessary to do more work with magnesium and boron before definite conclusions can be drawn in regard to their value as added plant nutrients to New Hampshire soils. All New Hampshire soils seem to be naturally low in available phosphorus. The potassium content varies somewhat with the soil type but in general some increase in crop growth will be obtained from additions of potassium on practically all the soils. (*Purnell Fund*)

Soil Fertility Studies

Soil fertility experiments carried on over a period of years include: an experiment with hay on neglected hay lands, an experiment with legumes on neglected hay lands, an experiment with potatoes in a three-year rotation, a fertilizer experiment with legumes in the Connecticut Valley and experiments with topdressing old pastures. The agronomic work in the studies is conducted by F. S. Prince and P. T. Blood; the chemical phases by T. G. Phillips and G. P. Percival.

Hay on Neglected Hay Lands

Significant differences for the treatment are apparent over a three-year period. As compared with no fertilizer, nitrogen at 200 lbs. per acre gave an average increase of 1,462 lbs. per acre of cured hay; 200 lbs. 16 per cent. superphosphate and 60 lbs. KCl gave 728 lbs. increase and the nitrogen-phosphorus-potash plot yielded 2,159 lbs. increase. The data indicate that nitrogen gives the greatest stimulation to yields but that phosphorus and potash, either one or both, are likewise limiting factors to the production of grass hay on this land.

The data from this experimental work will be included in a forthcoming Experiment Station publication, "Experiments with Timothy."

Legumes on Neglected Hay Lands

The old Whenal alfalfa plots were so reduced in stand in 1936 that it was decided to plow the land, cultivate it for one season and then seed back to alfalfa. Accordingly, sweet corn was grown there in 1937. Fertilizer was applied to all plots uniformly at the rate of 300 pounds of 8-16-16 per acre so as not to change the variables for the alfalfa that is to follow. No yield records on the sweet corn were taken. Alfalfa will again be seeded on the land in 1938.

Alfalfa is being grown on the Ireland farm as a sub-project in the legume experiment. In this test no manure was used. Moderate to heavy applications of fertilizer are annually applied to determine the nutrient levels at which alfalfa does best under those conditions. A test is included in which lime was applied at rates of from 0 to 8 tons per acre. These plots have been uniformly fertilized with 300 pounds of 10-20-20 fertilizer or its equivalent. A two-year summary of both cuttings showed significant decreases for the no-lime and one-ton series as regards lime applications. The fertilizer plots indicate that it is doubtful if an application of more than 30 pounds of nitrogen or more than 120 pounds each of phosphoric acid and potash are justifiable under actual farm conditions. The response for nitrogen in this field is rather striking. Thirty pounds of elemental nitrogen gave an increase of 1,028 lbs. hay in the first cutting. On the other hand, the doubling of nitrogen did not result in a marked increase in yield in either cutting.

A Dairy Farm Rotation on Worn-out Hay Lands

In this fertilizer ratio experiment on the potato crop at the Lane Farm in Pittsfield, the potatoes are grown in a rotation of potatoes, oats, and clover. All of the fertilizer is applied to the potatoes. The

oats as well as the first crop of clover are made into hay and removed, while the second crop of clover is plowed under either in the fall or spring before the potatoes are planted.

Potatoes have now been grown five years on the different parts of this field.

The differences for the 4-8-0, 4-0-7, no fertilizer and for the ½ ton of 8-16-14 are the only significant ones.

Omitting the phosphorus causes a 42-bushel decrease in yield, but increasing this element does not cause so large an increase as has been recorded on the more acid soils of Coos County. Whether this is due to the better availability of the element on the Lane soil or to larger stocks of native phosphorus is, of course, debatable. We suspect, however, that the Coos soil has a much stronger fixing power for phosphorus than the one in this experiment.

Omitting the potash causes a yield decline of 58 bushels of potatoes, while doubling the potash has resulted in an increase of 21 bushels per acre. The latter figure is not significant but the gain has usually been positive.

Two series in this test have received lime at the rate of 500 and 1,000 pounds per acre. The original soil pH was 5.3. So far, the lime applications have neither influenced the growth of potatoes nor the development of scab.

An Experiment with Potatoes in a Three-Year Rotation

On this field at the Jackson Farm in Colebrook, potatoes are grown in a three-year rotation of potatoes, oats, and hay. A seeding of mixed clover and timothy is always made for hay, since the soil is very acid and satisfactory pure stands of clover cannot be produced. The fertilizer is all applied for the potato crop, the oats and clover that follow being produced on residual fertility. The first crop of hay is cut and removed while the second crop is turned under before the potatoes are planted.

The experiment as laid out at present has been harvested four years. As compared with the check plots on which one ton of 4-8-7 was applied, significant results were secured by the following treatments: on the 4-16-7 plot a 23-bushel increase; on the 4-16-14 plot, a 46-bushel increase; on the plot using one-half ton 4-8-7 made up with Ammo Phos A and nitrate of potash, a decrease of 84 bushels; on the 2TL, 1T 4-8-0 plot, 141 bushels decrease.

The figures serve to emphasize the increase for phosphorus previously reported on this land, and the need for a higher ratio of phosphorus and potash to nitrogen than is found in the 4-8-7 fertilizer. Magnesium in the fertilizer apparently has little effect on yield and the phosphorus in basic slag does not give a significant increase in the potato crop over that from superphosphate.

Fertilizers made up from Ammo Phos 11-48-0 and nitrate of potash 13-0-44, equalling ½, 1T. and 1½ T. 4-8-7 have not given equivalent results with the regular 4-8-7 with potatoes. Moreover, these fertilizers seriously depress clover stands because of the acid residues they leave in the soil.

On the oats crops it is apparent from the data that lime and phosphorus are both effective in stimulating oats yields. The 4-16-7 and 4-16-14 both give positive increases and the basic slag series, either because it carries lime or because the slag holds the availability of the phosphorus better, caused a stimulation in yield.

The lime applications all caused yield increases, although the increase for the 500-pound application is scarcely large enough to be significant. In the series without potash (2 T. L.; 1 T. 4-8-0), lime apparently more than compensates for the omission of potash in oats growth.

Data for the hay crops show significant increases for use of lime. This is not surprising considering the acidity of the soil. Even the 500- and 1,000-pound applications cause significant yield increases. The use of basic slag to stimulate clover is apparently justified, for with a yield increase of this extent the extra cost of slag over superphosphate would be more than paid.

Experiments in Topdressing Old Pastures

A five-year summary of the tests conducted at the Seavey Farm in Stratham shows that the principal response on this pasture may be attributed to the element nitrogen. Although for the past two seasons more or less wild Dutch clover has appeared, it is not entirely possible to correlate this appearance with fertilizer treatment as has been the case on the Livingston pasture. Of the nitrogen carriers sulphate of ammonia ranks first, nitrate of soda second, Cal nitro third, and cyanamid fourth. Fifty pounds of nitrogen from cyanamid has not given much more stimulation to the grass so far than has 25 pounds of nitrogen from nitrate of soda.

With respect to the annual and triennial applications of phosphorus and potash, the large triennial application of phosphorus and the smaller annual application of potash seem to be superior. It is doubtful whether yield differences are sufficient to be significant, however. The response for these elements applied singly is small, but their combination increases yields and protein to a significant degree.

When added to nitrogen, however, a corresponding increase over nitrogen alone is not apparent. It may well be that moisture is a limiting factor to yields after a certain point on this soil.

In the plots on the Livingston Farm at Claremont, nitrogenous fertilizers alone fell considerably short of the 8-16-16 and 0-20-20 plot.

This difference in yield response may be ascribed to the appearance of wild white Dutch clover in the plots where phosphorus and potash are applied and its non-appearance where none is used. Furthermore, the character of the vegetation produced with nitrogen alone is not so satisfactory for pasture as that where the other elements are used or where complete fertilizers are applied.

With respect to nitrogen carriers, nitrate of soda seems to be superior on this soil. (*Purnell Fund*)

A Soil Survey of New Hampshire

This project was started in 1935 and during that season Grafton County was completed and Sullivan County started. In 1936 the Sullivan area was completed and the Cheshire and Coos areas were begun.

During the 1937 season Cheshire County has been completed by C. S. Simmons and W. H. Lyford and the report for Sullivan-Cheshire is now being prepared for publication in one report. The Hillsboro County survey has been begun.

The Coos County survey has also been completed during 1937 by B. H. Williams, W. H. Coates and P. N. Scripture, and the report is now being written. (*Purnell Fund in cooperation with the Bureau of Chemistry and Soils, U. S. D. A.*)

Grass Experiments in Hay Topdressing

A four-year average of plots on the Mathes Field in Durham shows that Cal nitro has produced more hay than any other nitrogen carrier. This is, however, closely followed by sulphate of ammonia, nitrate of soda, cyanamid and calcium nitrate. Amounts of nitrogen used were 32 pounds per acre. Cyanamid was applied as early as possible, usually about March 30, sulphate of ammonia about April 5 and the other carriers as near April 15 as weather would permit.

One hundred pounds of nitrate of soda gave more increase in hay per unit of nitrogen applied than either the 200- or 400-pound applications.

Nitrate applied April 25 was found superior to that applied either April 15 or April 5.

A home-mixed 8-6-6, compounded with Ammo Phos A and nitrate of potash with extra nitrogen from Cal nitro, gave better returns than a commercial 8-6-6. On this soil, phosphorus and potash have produced a larger increase in hay than these same elements on a similar sward at Greenland. (*Hatch Fund*)

Silage Corn Variety Tests

Tests of silage corn varieties by L. J. Higgins at the Whenal Farm, Greenland, showed that some of the early maturing varieties had a much higher percentage of dry matter but the yield of dry matter per acre was low due to the small growth and yield of silage. With some of the later and more rank growing varieties, although the percentage of dry matter was low, the greater yield raised the amount of dry matter per acre to a higher average than the early maturing varieties. It would seem that high yielding silage varieties not only give more succulence but also return more dry matter per acre. Top varieties in order of dry matter per acre were E. Eureka Ensilage, Sure Crop (55147), Pamunkey, Tuxpan and Virginia Eureka. (*Hatch Fund*)

Soil Testing and Recommendations for Tests

For several years a soil testing service has been maintained at the Experiment Station which takes care of soil samples sent in by county agents and farmers. The Agricultural Conservation Program has occasioned the sending in of more samples than usual during 1937. From Jan. 1 to Nov. 15, more than 3,000 samples have been tested. Recommendations for more than 2,000 samples were made in the past fiscal year. During July, 1937, a soil testing school was held for county agents where they were instructed on how to interpret the tests and

make recommendations therefor. Since August first the agents have been handling the recommendations, although the tests are still being run at the Station.

During the year it seemed advisable to summarize a large number of tests to find out in a general way how these were running and to assist those who are to suggest lime and fertilizer treatment for the soils that are to be tested. It is impossible in this report to cover all the details of how soil test recommendations are made, but this general summary is presented here to indicate how the soils tested and why a relatively high fertilizer schedule is necessary:

	Number of Tests					
	Nitrates	Ammonia	Phosphorus	Potassium	Magnesium	Calcium
None	201	0	0	426	6	12
Trace	166	7	0	225	393*	471
Very low	149	660	581	185	412	227
Low	202	300	354	60	135	82
Medium	143	17	45	29	32	42
Med.-High	69	2	14	9		36
High	59	10	4	12	15	55
Very high	11	4	2	54	7	75

* Marked "extra low" on test.

To interpret properly and make recommendations for these tests one has to take into consideration the fertility requirements of the crop to be grown, the soil type and organic content, the probable fixation power of the soil for phosphorus and its acidity. For example, soils testing "none," "trace," or "very low" nitrates and ammonia nitrogen should have an application of nitrogen for all crops. Soils testing "low" would probably be satisfactory for legumes but should be topdressed with nitrogen for grass hay, or if corn or potatoes are to be grown, manure or nitrogenous fertilizers should be applied. Soils testing medium should be satisfactory for hay or corn, but would need more nitrogen for potatoes.

A soil testing "very low" or lower for phosphorous should have phosphorus for any crop. One at "low" is suitable for grass hay but for no other, and then only in case the field is an established sod where the fertilizer is intended for topdressing. It can thus be seen that 935 samples, or 93.5%, of these soils should have a phosphorus application for full yields of all crops save grass hay and 58.1% should be treated with phosphorus even for grass hay increases.

Likewise 83.6% of the samples fall below the requirements of all crops for potash. If legumes are to be seeded and the soil tests "trace" or "none" for potash, an application of potash in fertilizer should be used even though manure is applied.

Soils showing "extra low" or "no" magnesium should have this element supplied in fertilizers except in cases where manure is to be used for the crop.

The pH range of these 1,000 samples is as follows:

pH Range	No. of samples
Below 5.0	117
5.0-5.5	468
5.5-6.0	278
6.0-	137

Below pH 5.0, a soil should be limed no matter what crop is to be grown. Between pH 5.0 and pH 5.5, soils should be limed for clover and alfalfa, and in the lower ranges for all crops. Between pH 5.5 and pH 6.0, a soil is satisfactory for clovers and other crops except alfalfa and sweet clover. For alfalfa and sweet clover a test of pH 6.0 or above is satisfactory.

Special rules for liming in potato rotations have been formulated and distributed to potato growers as follows in order to avoid trouble from potato scab:

"1. On soil with pH 5.3 or above, use no lime.
2. On soil with pH 5.0-5.2, use not more than 500 pounds of lime.
3. On soil below pH 5.0, use not more than 1,000 pounds of lime.
4. Never use more than 1,000 pounds of lime at one application, no matter how acid the soil.
5. Lime after the potatoes are grown, when seeding down, and never just before planting the potato crop.

"The amounts of lime stated are for ground limestone." (*Miscellaneous Income*)

A Study of Pasture Species Under New Hampshire Conditions

This experiment was started in 1936 with the planting of small plots in duplicate in pure lines and mixtures of species suitable for pasture. Certain pure lines and mixtures were also seeded in duplicate in larger plots for pasture.

The small plots were observed during 1937 for persistence and growth habits. Samples were obtained from the pure line plots for chemical work. These were taken as near the same stage of maturity in each case as possible.

The mild winter of 1936-37 was not one to give the various species a severe test and no winterkilling was observed in any of them. In this test there are now growing 42 alfalfa varieties or strains, 13 Dutch clovers, 16 red and alsike clovers and 10 species of grasses. In addition to the pasture species there are 40 lawn and golf green plots, twenty of each, which include 10 pure lines or mixtures in duplicate in each case. It is hoped in this test to determine the best lawn and golf species for New Hampshire conditions.

This experiment is being conducted so that it can be used as a trial ground for new species that seem worthy of testing either from local sources or from the Regional Laboratory at State College, Pennsylvania.

The larger plots which were seeded in an adjacent area were pastured during 1937. One end of this area was so wet during May and early June that it was felt inadvisable to pasture the plots until the soil was firm. Orchard grass and smooth brome grass were so large and woody by this time that the cattle would not eat them. After the cows were taken out these plots were mowed.

Later recovery indicated that these larger growing species are superior for summer pasture to some of the smaller growing grasses, including the blue grasses and rough stalked meadow grass.

Plots with alfalfa proved to be the most palatable and produced the most forage. The alfalfa seedings were distinctly superior to sweet and Dutch clovers in amounts of forage produced. This fact would appear to indicate that alfalfa should be included in pasture seedings on land adapted to the crop. (*Bankhead-Jones Fund*)

Tests of TVA Fertilizer

Tests of phosphatic materials furnished by the Tennessee Valley Authority were quite promising in both greenhouse and field trials and will be continued. The materials were checked against regular superphosphate to provide the equivalent amounts of P_2O_5. In the greenhouse tests three different soils were selected from the Experiment Station plots at Greenland and are members of the same soil type but have received vastly different treatment in the past few years.

Soil No. 1 has received neither fertilizer nor lime nor has it been cultivated for at least twenty-five years.

Soil No. 2 was seeded to alfalfa in 1931. It has received an application of complete fertilizer every year since then. It was plowed and reseeded to alfalfa in 1934. No lime has ever been applied.

Soil No. 3 has also been in alfalfa since 1931 and has received identical fertilizer treatment as No. 2, but in addition a heavy application of lime was made at the time of seeding the alfalfa in 1931. None has been applied since.

On Soil No. 1 ordinary 16% superphosphate gave best returns in the greenhouse test with treble-superphosphate and fused white phosphate rock running next. On Soil No. 2 calcium metaphosphate, treble-superphosphate, dicalcium phosphate with silica added, and fused brown phosphate rock surpassed 16% superphosphate. On soil No. 3 monocalcium and magnesium phosphate, calcium metaphosphate and fused white phosphate rock outran 16% superphosphate.

In the field trials the treble-superphosphate ran highest but the differences are not believed to be significant. For field work the calcium metaphosphate (65.5% P_2O_5) is the most difficult to handle as it is quite finely divided. Moreover, the material must be applied in smaller quantities since it has the highest concentration of phosphoric acid of any of the carriers. This may account for a slight decrease in yield in this plot. (*Bankhead-Jones Offset Fund in cooperation with Tennessee Valley Authority.*)

Cyanamid on Corn

Tests of cyanamid were made on corn at the rate of 300 pounds per acre on the Lane Farm in Chichester. The fertilizer was plowed under with manure to see whether the corn would utilize more plant food in its growth, either from the cyanamid or from the more rapidly decaying manure.

The average increase for the three plots was 1,102 pounds of corn valued at $8.75. The cost of the cyanamid was $5.85, leaving a net of $2.90 for its use.

These differences are undoubtedly significant as the probable error on the cyanamid plots is only ±56. (*Purnell Fund*)

Lime Applications on Potatoes

Attempts to counteract the influence of lime on promoting scab on potatoes have been made for several years on plots on the Jackson Farm in Colebrook, with varying amounts of lime as well as with basic slag, which is a lime-bearing substance.

The plots which were neutralized with 900 pounds of aluminum sulphate showed a slight reduction in badly scabbed tubers, as well as a reduction in pH to the same level as when two tons of lime had been applied.

The scab counts on series where four tons of lime were applied in 1929 indicate much less scab, especially in the "bad" grouping, where the potash has for several rotations been omitted from the fertilizer.

Slag appears to be quite effective in raising the pH level, with an increase in scab counts. Two applications of fertilizer with slag have been applied to these plots.

Five hundred and 1,000 pounds of limestone have had no appreciable effect on pH level and very little effect on promoting scab.

A critical study of these data indicates that the amount of lime applied at one time has more influence on scab than any other factor. Large applications of lime at one spreading are difficult to incorporate thoroughly into the soil so that neutral or nearly neutral areas are maintained by groups of lime particles not separated in the harrowing and working of the soil through the years. For this reason small applications of lime are preferable in potato rotations. (*Purnell Fund*)

Protein Requirements of Chickens

Further experiments in feeding chickens varying levels of proteins corroborate previous findings.

1. Those groups receiving 19 per cent. protein level in rations showed, generally, more rapid weight gains than those receiving low protein rations during the first twelve-week period. The groups receiving fish meal as sole source of animal protein were most efficient in weight gains and feed consumption.

2. The dried skim milk fed groups showed the lowest mortality with the mixed ration fed lots having the highest mortality.

3. At the age of 161 days all groups showed production to some extent with the fish meal groups leading. The experiment was conducted by A. E. Tepper, R. C. Durgin and T. B. Charles. (*Purnell Fund*)

Vitamin A Requirements

Further studies of the vitamin A requirements for growing chicks were made with four groups of five chicks each derived from a cross of Barred Rock females with a New Hampshire male.

The vitamin A concentrate was incorporated in Wesson Oil in a homogeneous mass to provide solutions having a potency of 48, 98 and 158 International units per .4 cc. These solutions were then incorporated within the basal ration to provide 134.4, 274.4 and 442.4 International units per 100 grams of total feed. Feed was mixed fresh each week and kept tightly sealed in containers.

The basal ration consisted of 46 lbs. ground white corn, 20 lbs. ground wheat, 5 lbs. wheat bran, 15 lbs. dried skim milk, 10 lbs. meat scrap, 1 lb. salt, 2 lbs. calcium carbonate and 1 lb. irradiated yeast (4,000,000 U. S. P. units per pound). The control group received the basal ration only with no addition of vitamin A.

The investigators, A. E. Tepper and R. C. Durgin, conclude that for rapid growth chicks with a normal storage of vitamin A upon hatching need during the first five-week period a total intake of approximately 134.4 International units of vitamin A per 100 grams of feed. Following this initial growth period the demands for vitamin A are increased to approximately 400 units per 100 grams of feed. (*Purnell Fund*)

Individual Cage for Poultry Nutrition Studies

In the development of chicken nutrition studies, need has been felt for an individual chick cage (1) capable of brooding with low mortality, (2) capable of furnishing quarters for one chicken from baby chick age to maturity, (3) so constructed that sanitation may be properly controlled, (4) containing a type of feeder which will allow a very minimum of waste, (5) containing a dropping pan suitable for use in the event of chemical feces examination and, (6) so proportioned and constructed that a series of cages may be maintained with the least effort and minimum requirement of space.

With these principles in mind, a cage was designed and built by A. E. Tepper; and in consultation with other members of the staff a new feeder was designed with a small feed opening and "baffle" plates to prevent feed waste.

A two-year trial of these cages in connection with vitamin A studies has proved their value. In all trials a livability of 100% to six weeks of age has been obtained. Chicks can be maintained in these cages beyond the initial brooding period. Sanitation is controlled by removable wire floors, a larger wire mesh floor being substituted after the first three weeks. Metal dropping pans collect feces and are easily cleaned. The feeder can be so managed as to provide a minimum of waste.

For those who wish further construction details concerning these individual cages a set of complete plans is available. (*Purnell Fund*)

Confinement vs. Open Range for Bronze Turkey Breeders

To observe the effects of confinement of turkey breeders under the stimulus of artificial lighting, two groups of Bronze turkeys were se-

lected on December 17, 1936, by T. B. Charles, P. A. Wilcox, D. W. Flagg, and A. E. Tepper. One group was cared for in complete confinement and the other on open range. Several toms were used during the breeding season alternating twice each week.

As soon as the birds in group one were confined to the pen, the application of morning lights was started and managed as with chickens. All birds were fed the New England Conference turkey breeder ration with the addition of supplementary feedings of condensed buttermilk and moist mash.

The birds in the confined group started to lay on January 11, eight weeks previous to the start of production from the range-managed birds. The confined group averaged 36.08 eggs per bird, and the range group 30.45 eggs per bird over the twenty-four-week test period.

There was a marked difference in type of feed consumed by the two lots. Those confined had an approximate mash-scratch intake ratio of 3:1 while the group on the range ate in the proportion of 1:2.

The weight of birds in both groups averaged approximately the same at the start and finish of the experimental period. The weight per bird increased up to the time of egg production after which a noticeable decline in weight took place.

It is evident that through confinement of turkey breeders and use of artificial lights egg production can be stimulated and birds induced to lay early in the season. No significant differences in egg size, maintenance of body weight or hatchability were apparent. (*State Fund*)

Range Shelter vs. Continued Use of Colony Brooder House in the Rearing of New Hampshires

Two groups of 350 New Hampshire chicks were started under gas brooders by T. B. Charles, A. E. Tepper, P. A. Wilcox and R. C. Durgin in colony houses on March 25, 1937, and managed similarly in all respects up to nine weeks of age. At this period one group was transferred to a range shelter with the use of limited range area and the other allowed a similar range area but continued to range from colony house. The application of heat to both groups was discontinued in the seventh week. Male birds were removed in the fourth week.

Detailed records on mortality, growth, feather development, feed consumption and sexual maturity were maintained. The total mortality through the twenty-four-week test period for the range group was 2.57 per cent. and for the colony house group 2.85 per cent. All deaths occurred previous to the fourth week of age.

At the time of transfer to range areas both groups weighed approximately the same, i. e., 1.7 pounds per pullet. At the end of the test period the group in range shelter averaged 4.88 pounds per bird and the group in colony house averaged 4.92 pounds per bird.

The group ranging from colony house consumed a total of 28.043 lbs. of feed per bird over the test period whereas the range shelter group consumed but 25.912 lbs. per bird.

Although the date of first egg (August 19) was the same for both groups the rate of production was significantly different. The colony

house group laid a total of 246 eggs as compared with 102 eggs for the range shelter group during the last three weeks of the test period.

Aside from the characteristic of early rate of production, pullets reared by either method should be of equal quality. (*State Fund*)

Test of Gas-Burning Brooders

To test the efficiency of gas (bottled) burning brooders, two were installed in 10′ x 12′ colony houses by T. B. Charles and Philip Wilcox. This test ran from March 25 to May 19, 1937. Gas meters were installed on each brooder so that a daily, as well as weekly, record of gas consumption could be recorded. Both groups were managed in a similar manner, and were fed the New England College Feed Conference ration for growing chicks.

Detailed records on growth, feathering, mortality and feed consumption were kept. Two groups of 350 New Hampshire chicks were started on March 25, 1937. Heat was discontinued on both lots during the seventh week.

Mortality was very low, being 2.57% in one house and 2.85% in the other, up to eight weeks, the period of this test. The pullets from both groups were carried to maturity without any further loss.

Chicks in one house required 152 lbs. of gas for the brooding period, and in the other, 93 lbs. of gas. This difference in gas consumption was due to mechanical difficulties with one burner which have been corrected. The average cost of fuel was 2.45 cents based on total number of chicks started.

At six weeks of age the cockerels were segregated to other pens. At eight weeks of age the pullets averaged to weigh 1.465 lbs., with an average consumption of 4.846 lbs. of feed.

Chicks under the gas-burning brooders used in this test, reacted similarly to chicks under a coal-, oil- or wood-burning brooder. They formed the typical ring of chicks at night. Chick movement was recorded throughout the night for comparative study with other types of brooding units. (*State Fund*)

Weathering and Lime-Sulphur Injury

Studies of the effect of weathering on lime-sulphur injuries made by O. Butler indicated that weathering does not increase the injury when lime-sulphur alone is used, but caused marked increase when either calcium arsenate or acid lead arsenate is added to it.

Previous work has shown that the addition of one per cent. cane sugar to lime-sulphur reduces injury to the bean between 10 and 30 per cent., and an experiment was made to test its value in the case of the apple. The addition of sugar reduced the injury and may be expected to offer a protection similar to that obtained on the bean.

The development of chlorotic foliage on the apple early in the season, the leaves assuming a bright and uniform yellow color, has been ascribed to spray injury, but it seems improbable that this coloration is due to other than natural causes. Chlorosis due to spray injury that we have obtained experimentally causes a mottling of the foliage promptly followed by leaf-fall, not a uniform yellowing of the leaf. (*Adams Fund*)

Fertilizer Placement with Potatoes

Distribution of fertilizer in bands at one-half inch distance or even contiguous to the potato seed piece was not found to interfere with sprout emergence in studies made by Stuart Dunn. The sprouts from the fertilized seed pieces emerged at the same mean rate as the sprouts from the non-fertilized seed, confirming previous experience. The rate of emergence of the sprouts from the distal seed pieces was more rapid than from the basal pieces, but the weekly growth rate declined sooner in the former. Tuber set was greatly increased and equally in the case of both series of fertilized plants and was not affected by the temperature at which the potatoes were grown. Tuber yield was greatly increased by the fertilizer, there being no noticeable difference due to amount used in the case of the plants grown at 20° C., but in the cultures at 15° C. the results obtained were irregular. (*Adams Fund*)

Leaf-Roll Potatoes Deteriorate

After eight successive years no evidence is available of the loss of productivity of potatoes effected with mosaic, reports O. Butler, but leaf-roll plants have grown less productive from year to year and the last remaining ones failed to produce a single tuber large enough to make two seed pieces. (*Purnell Fund*)

Study of Bovine Mastitis

In studies of diagnostic tests for mastitis L. W. Slanetz reports that the blood agar plate, and the microscopic test have given the best results to date, although it has been found difficult to make an accurate diagnosis using only one test. The Burri slant method gave results comparable with the blood agar plate and the microscopic test, but was not as satisfactory for general purposes as the former. The strip-cup and brom thymol blue tests only detected animals in more advanced stages of infection.

Three hundred and fifty strains of streptococci have been isolated from infected cows and approximately 90 per cent. of these strains have been tentatively identified as *Streptococcus agalactiae*. One hundred strains of staphylococci isolated from cows in the test herds are also being studied.

The value of vaccines, chemicals, and segregation for the treatment and control of mastitis is being studied.

A new drug—Prontylin (powder form)—Prontysil (liquid form)—has been used by Dr. Martin on several affected cows. The recommended dosage for this disease was not known. A small amount was used over a two-weeks' period, and no beneficial results were obtained. More work will be done with this drug in connection with treating mastitis. (*Purnell Fund*)

Haemolytic Streptococci in Pasteurized Milk

The studies on the haemolytic streptococci in pasteurized milk were brought to a conclusion by L. W. Slanetz during the year. Sixty strains, 35 from pasteurized milk, 7 from utensils, and 2 from cow teats, have been studied in detail and classified in five groups. The streptococci in

two groups do not appear to have been described in the literature and are sufficiently distinct from the other recognized forms to be considered distinct varieties. It has been found that the majority of the streptococci enter the milk from utensils which have not been adequately cleaned and sterilized. (*Hatch Fund*)

Spraying for Apple Scab

Seven years' study of the rate of maturation and discharge of apple scab spores indicates that there is no one environmental factor primarily responsible for the variations that are met with from year to year. Data have been taken by Stuart Dunn and O. Butler on snow cover, mean winter temperature to April 1st, mean temperature between April 1st and pre-pink spray application for scab control, amount and average duration of rainfall between April 1st and pre-pink.

During the period ascospore discharge has occurred once prior to the date of application of the pre-pink spray, twice on the date of the pre-pink spray, and during the remainder of the seasons in the interval between the application of the pre-pink and pink sprays. The stages of vegetation of the tree now in use for timing the spray applications for scab control are, therefore, entirely adequate for the purpose.

Following the initial ascospore ejection, discharges occur at intervals for about two months, but they do not occur during every rain. Generally, discharges are most abundant between the time of application of the pink spray and the first cover spray with the greater frequency sometimes before the calyx, sometimes after. Usually the period between the first and second cover sprays is one in which the fungus shows little or no activity. Relation of this data to the per cent. of scab on McIntosh indicates that the seriousness of infection in any one season bears no direct relation to the number of ascospore discharges that occurred.

During the year in the spraying experiments on scab control, lime-sulphur and flotation sulphur were the fungicides used. In some plots two, in others three cover sprays were applied. In the case of lime-sulphur in some plots a spray gun was used, in others a tri-nozzle for the purpose primarily of studying effect of method of application on spray injury. No material difference between nozzles could be observed as regards the effect on spray injury, but a very marked difference in scab control was obtained. In the plots in which the tri-nozzle was used there was 9.2 per cent. scab, and in those sprayed with the gun 45.3 per cent. scab. The control of scab was unaffected by the addition of cane sugar to the lime-sulphur solution. (*Hatch Fund*)

Poison Ivy Control

Experiments in the control of poison ivy were made during the year by O. Butler, with sodium thiocyanate, using 10, 20, and 40 per cent. solutions. Plants sprayed early in the season with the 10 per cent. solution sent out new growth before the end of the summer, but the plants sprayed with the 20 and 40 per cent. solutions showed no signs of recovery. (*State Fund*)

Electric Brooding Practical

Further indications that electric brooding of chicks is practical and can be carried on under severe climatic conditions without auxiliary heat or excessive mortality are evident in the studies just completed by W. T. Ackerman, T. B. Charles, A. E. Tepper and G. M. Foulkrod. Detailed results of the recent work have been published in Experiment Station Bulletin 303, "Electric Brooding of Chicks," and include observations on the following subjects: (1) Floor insulation; (2) Labor and fuel costs for coal versus electric brooding; (3) Application of heat under brooder; (4) Relation of house floor area to brooder size; (5) Prevention of floor drafts; (6) Extended brooding period; (7) Effects of power ventilation; (8) Chick movement, and (9) Physiological needs of chicks. (*Purnell Fund*)

Avoid Home-Made Electric Fences

Home construction of electric fence units and devices should be discouraged, states W. T. Ackerman in a preliminary report of a study on this subject. The public should be advised that an electric fence, in its accepted definition, is *not* the plugging of the fence wires into a light socket without any controlling device. Several fatal accidents of record have resulted from attempting this method. On the other hand, tests conducted to date indicate that an electric fence having a controller device, all of which is manufactured by a competent electrical concern, can be both safe and effective. This kind is the only one that it is safe to recommend, and there is need for testing carefully all commercial units. (*State Funds*)

Wax Heating Equipment Developed

During a study of wax plucking of poultry, the demand for a simple automatic wax heater was evident. It was found that the commercial semi-scald heaters with the heating element in the water had quite a large variation of temperature between the lower part and the surface. This led to the assumption that a water-bath type of heater would give better results.

A small five-gallon water heater was secured, and it was found that a 12-quart milk-pail would just fit the cylindrical tank and not touch the bottom, leaving a water bath around the lower three-quarters of the pail, which would allow wax deep enough to dip the bird.

This heater was not automatic and a thermostat control was added with the bulb in the wax; the mechanism was mounted high enough to allow the removal of the bulb and protect the switch from splashing. The thermostat gave good control, allowing about a two-degree variation. The water-bath was small in volume and heated rapidly from a large heating element.

Suggestions for assembling such equipment on the farm are as follows:

1. The water-bath method of keeping the wax hot reaches all parts of the container and eliminates the possibility of the wax hardening around the upper edges and slowing up the work. This would allow

the heating unit to be external and a circulating water-bath used, if desired.

2. A hemispherical shape for the wax container would be ideal, for it would give the greatest working space for the smallest quantity of wax. This means that all the wax would be at the same temperature, which is practically impossible in a large cylindrical container.

3. With the small wax container the need for a heated supply to replenish that in the dipping vat is apparent. This can be done on any stove, as the temperature need not be controlled so accurately as in the dipping vat.

To speed up the drying between the semi-scald and waxing it was found that a ventilator fan with two-speed control filled the need well. (*Hatch Fund*)

Pneumatic Traction Equipment

In addition to the routine life, mileage and cost records being kept on tractor tires in use on the experimental farm a new problem arose during the 1936-37 operations. A series of cuts appeared inside the right rear tire of one of the tractors which it appeared were probably due to lug-type chains or exceedingly hard ground.

It was found that the inside fabric of the sidewall was broken at regular intervals all the way round the tire, some breaks penetrating to the outside surface. The tire was sent to the factory for inspection and adjustment. After a study of the causes the following schedule of pressure recommendations was made by the manufacturer: 16 to 18 pounds pressure in the furrow drive tire seems necessary to prevent damage to the fabric from overflexing or heating. This is six to eight pounds more pressure than is recommended for ordinary work, but it is pointed out that in plowing the tractor is operating on an angle and the furrow tire is carrying enough additional weight so that with the extra pressure it still keeps approximately the same deflection rate.

In using chains or lugs it is necessary to keep sufficient pressure so that there will not be excessive flexing of the tire as it rides up on the lug and down on the tire. Twelve to fourteen pounds seems to be the right pressure depending, of course, upon the size of the tire and the weight of the tractor.

Animal Metabolism Studies

The extraordinary influence of genetic adaptation and of season on the basal energy requirements of the individual, has been indicated in the studies in metabolism of cattle conducted by E. G. Ritzman in cooperation with the Carnegie Institution of Washington.

Measurements of the heat production of a Hereford cow given a fattening ration were compared with that of a Holstein cow fed for the production of about 25 pounds of milk. They indicate that the basal metabolism of the lactating cow was about 25 per cent. greater per unit of weight than that of the beef cow.

The practical inference is that the inherited traits play a far greater role in the use to which the animal body directs its food energy than does the character of the food.

Seasonal variations in basal metabolism of dairy bred cows (not lactating) amounting to as much as 50 per cent. and higher have been observed. The highest level of metabolism invariably occurred during May, June, and July, that is, during the period of longest sunlight when the extra heat is least necessary suggesting that this factor may play a dominant effect on stimulus of the body tissues. It is conclusive evidence that under ordinary conditions of environmental temperature the rate of heat loss from the body does not determine the rate of its production as has been believed heretofore.

Physiologically a fundamental study of metabolism and food utilization involves a study of many specific factors which may affect the production of heat or the disposal of excess heat under unusual conditions. Thus our studies in metabolism during the past year have also been carried out on the relatively little explored subject of the effect of environmental temperature on the metabolism of the various species of farm live stock, including cattle, sheep, goats, and the pig.

In a series of thirteen metabolism measurements of two Jersey cows kept under very carefully controlled conditions of temperature, feed and water intake, it was found that the basal metabolism increased from two to three per cent. for each degree drop in temperature below about 18° C. (64° F.) which is approximately the most comfortable temperature for adult cattle under ordinary conditions of feeding. The effect of blanketing at environmental temperatures of 8.5 to 9.5° C. reduced the heat production of these Jersey cows, when regularly fed, by four per cent. Numerous measurements of the relative amount of heat lost by vaporization indicated much lower values for the heat loss by this path than have been previously reported for cattle.

Metabolism measurements were also made of sheep at various temperature levels both before and after shearing. At a normal temperature of 18 to 22° C. shearing increased the basal heat production about 10 per cent., but when the environmental temperature was dropped to about 11° C. the heat production increased 33 per cent. above the level before shearing. Similar experiments with goats indicate somewhat the same metabolic reaction to temperature as does the sheared sheep.

A series of similar experiments begun with an adult Chester White sow is still in progress.

The technique and design of apparatus required for a study of these new problems in physiology constitute no small part of the efforts of research. Thus, our preliminary attempts to evolve a technique for the metabolism of the horse in action by means of a treadmill have found technical limitations which make this method of procedure unsuitable. This has led to the design of a special type of mask, based on a new principle of application. This mask is at present well along toward completion, and if satisfactory will be used to measure the energy production of the horse in action at different speeds.

During the year a manuscript has been prepared on the researches in metabolism and nutrition carried out primarily on cattle during the last eighteen years. This will be published in the monograph series of the Carnegie Institution of Washington under the title "Nutritional

Physiology of the Adult Ruminant" (about 200 pages). (*Purnell and Adams Funds*)

Sheep Breeding

In our investigations in sheep breeding, selection for the establishment of four functional nipples with a corresponding increase in milk yield and increase in twinning rate, has been continued by E. G. Ritzman. Out of 58 ewes bred, 28, or approximately 50 per cent. have four or more functional nipples.

Since this work was begun, other investigators in research on the endocrine functions have demonstrated that the development of the lobe and of the duct system of the mammary gland is directly caused by ovarian hormones, and that the actual secretion of milk results from hormone stimulus. These discoveries which explain the physiological basis of lactation are in accord with the theoretical heredity pattern proposed in an earlier report (N. H. Station bulletin 53) as a possible basis for eventual development into a prediction chart for the selection of breeding stock.

Progress in the establishment of the lactating function of these ewes has been rapid and consistent but in increasing the twinning rate has been rather sporadic. While this may be in part due to the fact that limitation in the size of the breeding flock has prohibited discarding single-born females, it nevertheless suggests that there is no specific causative relationship between these two typically sexual functions, i. e., fecundity and lactation.

While it must be generally recognized that increase in fecundity rests primarily on a hereditary basis, yet it is becoming more evident that proper nutrition has a very material influence in realizing the hereditary potentialities. These studies are being continued. (*Adams Fund*)

Contact Insecticides

In their study of contact insecticides, W. C. O'Kane, L. C. Glover and W. A. Westgate are investigating the rate of penetration of oils through insect integument. The work to date has been largely concerned with establishing a suitable technique for measuring the rate of penetration. This work has presented numerous technical difficulties. After extensive experimentation an apparatus has been devised which has the following elements. A large-bore glass tube is fused to a capillary glass tube. The end of the large-bore tube is pressed out into a disc of 9 mm. diameter, having a concave curvature similar to that of a sphere of ¾" radius. The center of the disc has an opening continuous with the tube. A series of these tubes is held firmly in a specially constructed metal-and-cork block, with movable sections.

The experimental insect used in all tests to date is the American cockroach, *Periplaneta americana.* The pronotum of the cockroach is dissected off and cemented to the glass disc, which has a curvature similar to that of the pronotum. The apparatus is filled to the top of the capillary tube with a mineral oil of low boiling point which is then sealed with cement. Thus the oil can escape only through the pronotum which is cemented to the disc. The rate of fall of the oil in the capil-

lary tube is taken as a measure of the rate of penetration of the pronotum. The ultimate aim of this study is to relate speed of penetration of an oil to its molecular structure or its chemical or physical properties. (*Purnell Fund*)

Insect Record

Particular attention was given by our entomologists this year to the outbreak of the European spruce sawfly which severely defoliated 300 acres of spruce on the north side of Mt. Monadnock. Studies will be made of the life history and control of this pest under New Hampshire conditions and are already under way to determine the effects of temperature on the hibernating larvae.

In cooperation with the State Department of Agriculture trap logs have again been placed for studies of the elm bark beetles which are known to transmit the Dutch elm disease. (*Hatch Fund*)

Seed Testing

The regular seed inspection work for the State Department of Agriculture was conducted as usual. During the year, 503 samples of seed were handled in the laboratory. Of this number 439 were collected by the State Inspector and are reported in Bulletin 299; the remaining 64 samples were sent in by private individuals. The referee work was done as usual. The work was done by Mrs. Bessie G. Sanborn, Seed Analyst, assisted by students. (*Miscellaneous Income*)

Seed Certification

Sixty-two acres of potatoes were entered for certification and 95.9 per cent. of the acreage entered passed final inspection. (*Miscellaneous Income*)

Calves Should be Vaccinated Young

Vaccination of calves as a means of control of Bang's Disease should take place before the animals are six months of age, finds C. L. Martin. Inoculations were given 21 cattle varying in age from four years to four months. Five head were between four and six months of age, and these five were the only ones to react negatively when tests were made within a year of inoculation. Since at the present time stock sold for breeding purposes or milk production must be negative to the blood test, the inoculation of older animals would appear to be inadvisable. (*Purnell Fund*)

Technique for the Eradication of Pullorum

Studies on cases of non-specific reactors encountered during routine testing of blood samples for Pullorum have been made by C. A. Bottorff to determine if other salmonella organisms were responsible.

In no case were any salmonella organisms found other than S. pullorum. The liver, ovaries, spleen, heart, and any pathological lesions found were cultured.

There were 176 birds from 79 flocks examined in this study. Of these, 134 birds from 68 flocks were classed as negative because Sal.

pullorum was not isolated. The remaining 42 birds from 11 flocks were positive.

This study shows the importance of necropsy in a flock that has only a few suspicious or positive reactors before giving an official rating on that flock. (*Purnell Fund*)

Acidophilus Milk Helps Control Coccidiosis

Birds affected with chronic coccidiosis, as shown by a recovery of the oocysts in the fecal material, were fed acidophilus milk (*Lactobacillus acidophilus*) for a period of one month by C. L. Martin, T. B. Charles, R. C. Durgin. At the end of that time a fecal examination showed no more oocysts of chronic coccidiosis; neither was there any indication that the Lactobacillus acidophilus organism had been implanted in the flora of the intestinal tract. The attempt will be made to isolate a chicken strain of this organism that may be inoculated into the intestinal tract in an effort to get a product that will remain viable.

During this past year there came to our attention a condition of chronic coccidiosis occurring in very young chicks, as early as three and four weeks of age. Associated with this disease was that of rickets. An analysis of the feed used showed it to have the proper amount of Vitamin "D" to protect chicks against rickets. It was thought that the coccidiosis condition was responsible for the rickets in that it damaged the intestinal tract to the extent that it could not absorb a sufficient amount of Vitamin "D."

Three lots of day old chicks, 20 to each lot, were used in an experiment to try to produce this condition. One lot, two weeks of age, and another four weeks of age were given oocysts of chronic coccidia, for a period of ten weeks. At the end of that time they were killed, intestines examined for lesions of chronic coccidiosis, a line test for rickets made of one tibia and an ash determination of the other tibia bone made.

Although a large percentage of the chicks in the inoculated groups showed lesions of chronic coccidiosis, none of them showed significant indications of the presence of rickets. (*Purnell Fund*)

Pullorum Eradication

All previous records for the number of blood samples tested for Pullorum in one season were broken during the testing season of 1936-1937. Under the supervision of the New Hampshire Department of Agriculture there were 549,482 blood samples tested from 442 flocks as compared to 370,176 samples from 284 flocks the previous season. This was an increase of the total per cent. of the total adult birds tested in the state from 30% in 1935-1936 to 47% in 1936-1937. Out of the 549,482 samples tested 99.64% or 547,486 samples tested did not react to the test for Pullorum. It is believed that no other state shows such a high percentage of the total number of birds in the state tested, with such a low percentage of infection, that is 47% of the adult birds tested and 36 hundredths of one per cent. infection.

The increase has been due to the lowered cost of testing to the poultrymen. The New Hampshire Department of Agriculture now pays

the laboratory cost of doing the test, and the poultrymen only pay the cost of collecting the blood samples.

During the past season 90 Pullorum Clean flocks tested 140,496 birds. There were 312 Pullorum Passed flocks tested having 358,729 birds. There were 181 flocks that tested 122,942 birds for the first time. There were 127 Pullorum Passed flocks having 211,530 birds that have been tested 100% with no reactors for two or more years. (*Miscellaneous Income*)

Bang's Disease Tests

The usual tests of Bang's Disease blood samples were made by the laboratory for the State Department of Agriculture. The total number of samples amounted to 22,026, of which 19,164 were Federal samples, 1,332 private samples from New Hampshire herds, and 1,530 from out-of-state. The tests were in charge of C. L. Martin. (*Miscellaneous Income*)

Poultry Autopsies

During the fiscal year 1936-1937, 2,210 poultry autopsies were performed by C. L. Martin and C. A. Bottorff at the Poultry Pathology Laboratories including 949 adult chickens, 1,082 chicks and 161 turkeys.

The principal diseases in adults were ruptured egg yolk, 23.5%, coccidiosis 13.0%, indigestion 10.5%, uremia 9.2%, leukemia 8.5%, pneumonia 7.8%, tumors 5.4%, impaction 4.5%, ulcerated gizzard 4.4% and round worms 4.4%.

The principal chick diseases were pneumonia 34.3%, ulcerated gizzard 19.6%, coccidiosis 10.9%, indigestion 10.1%, pullorum 7.2%, navel infection 3.4%, and epidemic tremors 3.4%. (*Miscellaneous Income*)

Fowl Pox Vaccine Distribution

The total number of doses of Fowl Pox Vaccine distributed to New Hampshire poultrymen during the fiscal year, 1936-1937, was 294,200. C. L. Martin. (*Miscellaneous Income*)

Laryngotracheitis Vaccine Distribution

During the past season 97,100 doses of Laryngotracheitis vaccine were distributed to poultrymen in New Hampshire. This vaccine was used in only five of the ten counties of the state. The distribution of this vaccine was carefully supervised and no vaccine was allowed to be used except under the following condition:

1. Properly diagnosed outbreak.
2. Where an outbreak had occurred the previous year.
3. Where a flock had been vaccinated the previous year.
4. Where one flock, or two closely adjoining flocks, has been vaccinated due to an outbreak. C. A. Bottorff. (*Miscellaneous Income*)

Feeding Stuffs and Fertilizer Inspections

In the enforcement of the law regulating the sale of concentrated commercial feeding stuffs, 400 brands were analyzed for the State De-

FINANCIAL STATEMENT

Expenditures of the New Hampshire Agricultural Experiment Station for the Year Ending June 30, 1937

	FEDERAL FUNDS						
	Hatch Fund	Adams Fund	Purnell Fund	Bankhead-Jones	Bankhead-Jones Offset	Supplementary*	Total
Personal services	$10,344.03	$13,001.68	$51,471.16	$3,678.09	$3,393.90	$19,754.67	$101,643.53
Supplies and materials	773.17	1,051.64	2,446.53	115.43	173.28	4,369.49	8,929.54
Communication service	708.26	2.75	62.64	.70	.30	363.13	1,137.78
Travel expenses	688.21	188.66	3,047.07	204.84	190.16	2,667.37	6,986.31
Transportation of things	305.49	62.49	139.44	18.59	13.37	84.62	624.00
Publications	681.28	.....	981.06	.....	220.14	224.98	2,107.46
Heat, light, water and power	701.10	.....	70.99	.66	.....	98.56	871.31
Contingent expenses	.....	.....	22.75	.....	.....	695.12	717.87
Equipment	798.46	627.29	1,336.00	160.29	187.45	1,494.08	4,603.57
Buildings and land	.....	65.49	422.36	.....	.....	437.04	924.89
Balance	.....	.....	.....	.....	.....	21,402.02	21,402.02
Totals	$15,000.00	$15,000.00	$60,000.00	$4,178.60	$4,178.60	$51,591.08	$149,948.28

*This fund includes expenditures from the following sources:

State appropriations	$1,494.90
Sales and miscellaneous income	50,096.18
	$51,591.08

partment of Agriculture. The analyses required about 3,000 individual determinations.

In the enforcement of the law regulating the sale of commercial fertilizers, 112 brands were analyzed for the State Department of Agriculture. These analyses required about 770 determinations.

Feeding stuffs, fertilizers and other miscellaneous materials to the number of 101 have been analyzed for residents of the state. About 280 individual determinations have been made on these samples. (*Miscellaneous Income*)

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* On Leave of Absence.
** January 15, 1938-January 15, 1939.

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